PhD: Planning in dynamic environments applied to service robots in nursing homes.

IMT Nord Europe
École Mines-Télécom
IMT-Université de Lille

FACULTÉ DE
GESTION,
ÉCONOMIE
& SCIENCES

Faculty of Management, Economics and Science (FGES) of the Catholic Institute of Lille and Institut Mines-Télécom Nord-Europe are joining forces to offer this thesis subject in computer science, applied to mobile robotics. The objective of this thesis is the implementation and evaluation of control and decision-making strategies for an autonomous mobile robot working in a medical environment in collaboration with healthcare personnel.

Background and Description

Many studies have shown the lack of personnel in health care structures such as nursing homes. These reports also mention “sustained pace”, “impeded work” and even “passive mistreatment”. A reality recently brought again to light with the book entitled “Les Fossoyeurs” by journalist Victor Castanet. The COVID19 health crisis has exacerbated this situation, in a sector that has already been in tension for several years. However, with the increase of life expectancy and the progression of new profiles of elderly or dependent people (alzheimer’s, trisomy, etc.), social interaction becomes predominant. Thus, the need for time and staff is growing to offer assistance adapted to each profile.

In this context, our work consists of using mobile robots to automate repetitive and/or tedious tasks in the daily logistics of healthcare establishments. The objective is to improve the quality of care while reducing the stress and fatigue of staff members. The use of robots would help refocus staff activities on care tasks, resident support and social care.

One of the major difficulties consists in providing robotic systems with the capacity to integrate humans (caregivers, medical staff and especially the elderly) and to prioritize their safety and comfort. Indeed, unlike robotics in an industrial environment, service robotics cannot escape certain social rules. For example, a robot must navigate the corridors taking into account the human presence, their possible intentions so as not to endanger, surprise or annoy them.

Partners

This thesis is part of a more global project bringing together scientific and private actors. The two main academic partners are:

- the ARTs group (Autonomous ResilienT Systems) of the Center of Education, Research and Innovation in Numeric Systems (CERI SN) of Institut Mines Télécom Nord-Europe represented by Luc Fabresse (thesis director), Guillaume Lozenguez (thesis co-supervisor) and Noury Bouraqadi (https://arts.wp.imt.fr/category/multi-robot-systems/)
- the Smart and Sustainable Cities team of the Faculty of Management, Economics and Sciences (FGES) of the Catholic Institute of Lille represented by Abir Karami (thesis co-supervisor)

This work is motivated by the desire of the elderly healthcare establishments partner to support this research: the EHPAD Notre-Dame de l’Accueil of the Feron-Vrau Association. This partner located in the Haut-de-France region will allow, on the one hand, to better identify and define the scenarios of interest and, on the other hand, to carry out on-site experiments in order to collect data and improve our models and simulations.

Mission

In collaboration with the partners, the work to be carried out within this thesis is based on several inter-dependent packages:

Environment modeling. It is a question of extending and adapting the representation that a robot has of its environment by integrating semantic annotations on the perceived elements and thus distinguishing static objects (wall, stairs …), semi-mobile objects (tables , chairs, doors, boxes, sideboards, wheelchairs, etc. or mobile objects (humans, other robots). Coupled with behavior and/or movement models, this representation will allow the robot to anticipate certain events. For example, a robot can adapt its navigation (trajectory, speed, etc.) differently in a corridor depending on whether it detects the presence of a static obstacle (e.g. laundry basket), another robot or a human (caregiver, elderly person).

Intent modeling and interactions with humans. Humans form a separate category in the robot's interaction processes with its environment. Robots must be able to observe humans and understand their intentions in order to anticipate their actions. Humans have different roles and are involved in the robot planning and learning process differently through interaction and feedback. For a medicine cart moving scenario, for example, the robot must follow the nurse. In particular, it must position itself and move according to his needs. The other humans around mostly form alerted mobile obstacles. An incremental level in scenarios aims to increase the number of interaction situations and roles handled by the system.

On-board planning. The models proposed above are complex and need resources to implement them efficiently on an autonomous robot which embeds limited computing resources (processor, memory, batteries). To tackle this problem, we can improve the control architectures by proposing dedicated modules to the performance of each precise algorithmic tasks (recognition of objects in the scene, inference of its behavior, etc.) and by studying their impact on existing modules. A modular approach improves agility regarding changes in the scenario or the environment, by potentially dynamically reconfiguring software processes.

Experiments. This involves developing prototypes to conduct experiments in order to validate all or part of the proposed models. These experiments will also make it possible to measure the impact of the models on the robot's behavior. They will initially consist of realistic simulations and then applied on real experimentation in collaboration with our partners (elderly healthcare home).

Candidacy

The candidate should hold a Master's degree in computer science or equivalent as well as basics in Artificial Intelligence. Knowledge of robotic systems, decision-making processes and/or machine learning approaches will be appreciated. Ideally, the candidate has experience working with ROS or ROS2.

To apply please send before 31th of May 2022

- A cover letter
- A Curriculum Vitae (CV)
- One or two letters of recommendation attesting to your qualities
- Master's grades report

to the list of supervisors: [mails]

Luc FABRESSE (luc.fabresse@imt-nord-europe.fr), Abir KARAMI (abir.karami@univ-catholille.fr) et Guillaume LOZENGUEZ (guillaume.lozenguez@imt-nord-europe.fr)

Ideally, contract starting date in September 2022